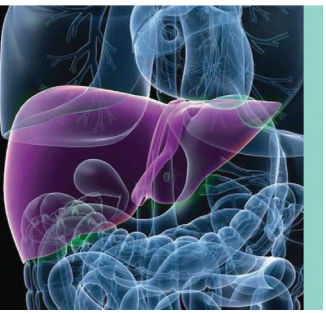

LI-RADS: Review and Updates

Mohab Elmohr, M.D., Khaled M. Elsayes, M.D.,† and Victoria Chernyak, M.D., M.S.‡*

The Liver Imaging Reporting and Data System (LI-RADS) is a comprehensive system that uses standardized terminology, technique, interpretation, and reporting of liver imaging. It has been developed by a multidisciplinary team of diagnostic and interventional radiologists, hepatobiliary surgeons, hepatologists, and hepatopathologists with the support of the American College of Radiology (ACR) in 2011.[1] Two diagnostic LI-RADS algorithms were developed for categorization of untreated imaging observations in patients at risk for development of hepatocellular carcinoma (HCC): computed tomography/magnetic resonance imaging LI-RADS (CT/MRI LI-RADS) and contrast-enhanced ultrasonography LI-RADS (CEUS LI-RADS).[2] LI-RADS for CT and MRI was released in 2011 and has undergone four major updates in 2013, 2014, 2017, and the latest being in 2018.[3-5] CEUS LI-RADS was developed in 2016 and was updated once in 2017.[2]

CT/MRI LI-RADS DIAGNOSTIC ALGORITHM

The CT/MRI diagnostic algorithm assigns a category for each observation based on its probability of benignity, malignancy, or HCC. The categories range from LR-1 (definitely benign) to LR-5 (definitely HCC) (Fig. 1). The LR-5 category has a specificity of approximately 95% for the diagnosis of HCC.[6] Three additional categories include LR-NC (not categorizable), LR-TIV (definite tumor in vein), and LR-M (probably or definitely malignant, not HCC specific).

Category assignment in LI-RADS is based on various combinations of five major imaging features and a number of ancillary features (AFs). Major features include nonrim arterial phase hyperenhancement (APHE), nonperipheral "washout," enhancing "capsule," size, and threshold growth (Fig. 2). The AFs are divided into three groups: AFs favoring malignancy in general, AFs favoring HCC in particular, and AFs favoring benignity. Once a category is assigned based on the present major features, the AFs can be optionally applied to adjust the category.[6] The presence of ≥1 AF favoring benignity or ≥1 AF favoring malignancy allows for the downgrade or upgrade of the assigned category by a single category, respectively. If ≥1 AF favoring benignity and ≥1 AF favoring malignancy are identified in

Abbreviations: AASLD, American Association for the Study of Liver Diseases; ACR, American College of Radiology; AF, ancillary feature; APHE, arterial phase hyperenhancement; CEUS, contrast-enhanced ultrasonography; CT, computed tomography; HCC, hepatocellular carcinoma; LI-RADS, Liver Imaging Reporting and Data System; MRI, magnetic resonance imaging; OPTN, Organ Procurement and Transplantation Network; TIV, tumor in vein.

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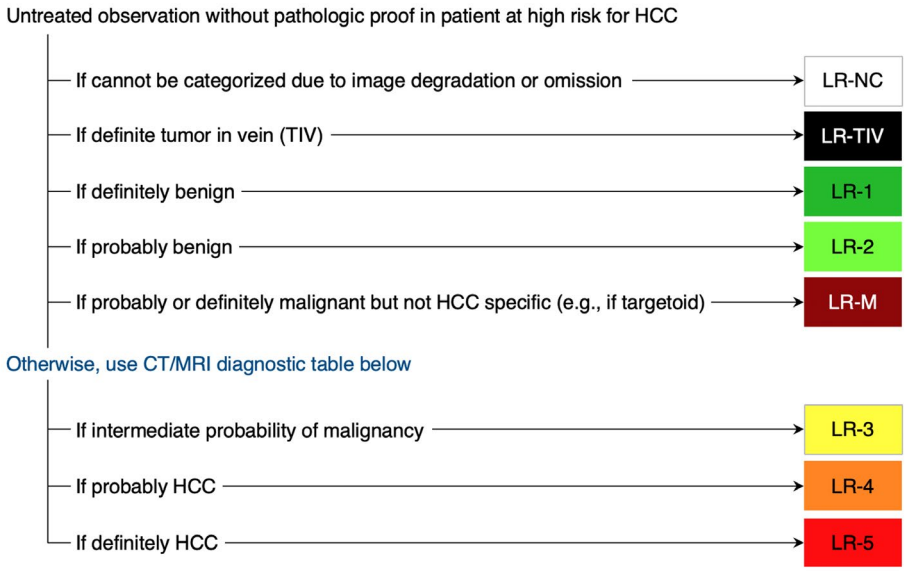

CT/MRI Diagnostic Table

Arterial phase hyperenhancement (APHE)		No APHE		Nonrim APHE		
Observation size (mm)		< 20	≥ 20	< 10	10-19	≥ 20
Count additional major features: • Enhancing "capsule" • "Nonperipheral "washout" • Threshold growth	None	LR-3	LR-3	LR-3	LR-3	LR-4
	One	LR-3	LR-4	LR-4	LR-4 / LR-5	LR-5
	≥ Two	LR-4	LR-4	LR-4	LR-5	LR-5

LR-4 / LR-5 Observations in this cell are categorized based on one additional major feature:
- LR-4 – if enhancing "capsule"
- LR-5 – if nonperipheral "washout" **OR** threshold growth

FIG 1 LI-RADS v2018 diagnostic algorithm for CT and MRI.[6] Reproduced under CC BY-NC-ND 4.0.

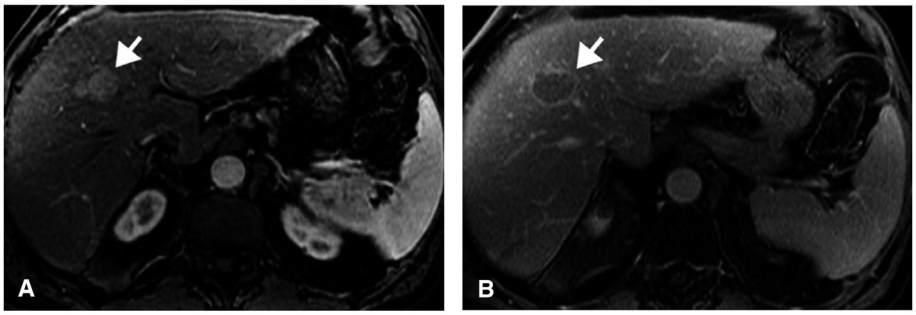

FIG 2 A 57-year-old man with HCC in the background of chronic hepatitis C–related cirrhosis. Axial postcontrast T1-weighted MRIs in the arterial (A) and the delayed phase (B) demonstrate a well-circumscribed oval observation measuring 2.5 cm in maximal dimension. This lesion exhibits homogeneous hyperenhancement in the arterial phase (arrow) with washout and enhancing capsule in the delayed phase (arrow) consistent with LR-5.

the same observation, the assigned category should not be adjusted. AFs cannot be used to upgrade the initially assigned category to LR-5.

LR-M category is assigned when at least one LR-M imaging feature is present. LR-M imaging features are divided into targetoid (rim APHE, peripheral "washout," delayed

central enhancement, targetoid restricted diffusion, targetoid transitional, or hepatobiliary phase appearance) and nontargetoid (markedly restricted diffusion, severe ischemia/necrosis, infiltrative appearance, or other features that in the radiologist's judgment indicate malignancy). Targetoid morphology is characteristic of intrahepatic cholangiocarcinoma, combined HCC-cholangiocarcinoma, and other non-HCC malignancies but can be seen in HCC with atypical appearance. Therefore, targetoid appearance suggests non-HCC malignancy but does not entirely exclude HCC. LR-TIV category is assigned when there is definite enhancing soft tissue in vein, not necessarily HCC. The significance of the LR-TIV category stems from the presence or absence of other imaging features to narrow the list of likely TIV etiologies. When LR-TIV category is assigned, the radiologist should indicate the most likely etiology in his or her report. LR-NC category is used when an observation cannot be categorized because of technical limitations impeding the identification of major features, such as image degradation or omission of a necessary imaging phase.

WHY WAS LI-RADS UPDATED IN 2018?

Current standards in the noninvasive imaging diagnosis of HCC follow the guidelines of the American Association for the Study of Liver Diseases (AASLD), the Organ Procurement and Transplantation Network (OPTN), and LI-RADS.[7] These guidelines agree on certain imaging features that should be present in an observation to have a high probability of being HCC. These features include a maximum size of at least 10 mm and the characteristic hyperenhancement in the late arterial phase.[6,7]

Distinct differences used to exist among the three guidelines in the categorization of hepatic lesions until the release of the latest LI-RADS guidelines for CT and MRI in 2018. The latest LI-RADS release comprised minor modifications to the prior version, which allowed for LI-RADS v2018 to be incorporated into the AASLD clinical practice guidelines, released in August 2018.[8] Integration of LI-RADS v2018 into AASLD clinical practice guidance was a major step toward achieving unified imaging criteria for HCC diagnosis in the United States. However, a complete unification is still not achieved, because minor differences remain between HCC diagnostic criteria set by OPTN and those set by LI-RADS v2018.

CHANGES IN LI-RADS v2018

The most important change introduced in v2018 affects categorization of 10- to 19-mm observations with nonrim APHE and nonperipheral "washout." In v2017 and earlier versions, visibility on an antecedent ultrasound was required for LR-5us categorization. In v2018, the requirement for ultrasound visibility was removed, so that all

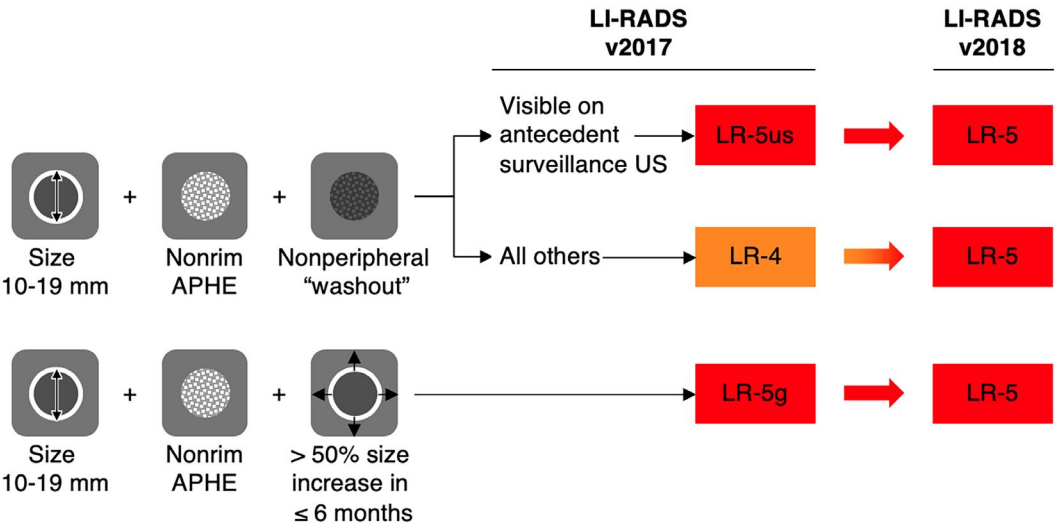

FIG 3 Changes in LI-RADS v2018 categories after removing the -us and -g designations.[6] Reproduced under CC BY-NC-ND 4.0.

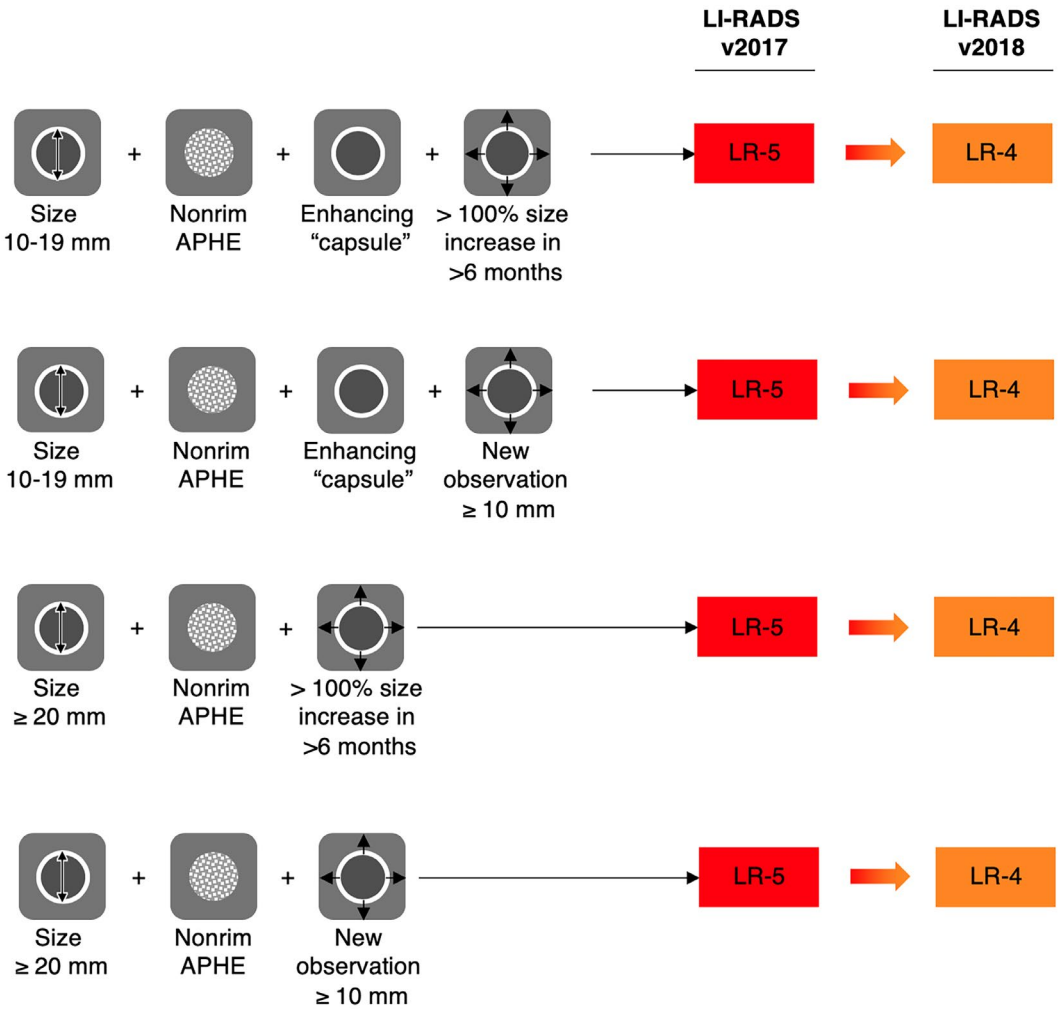

FIG 4 Changes in LI-RADS v2018 categories after the revision of "threshold growth" definition.[6] Reproduced under CC BY-NC-ND 4.0.

10- to 19-mm observations with nonrim APHE and nonperipheral "washout" are categorized LR-5 (Fig. 3).

In LI-RADS v2018, the definition of threshold growth was simplified to include only size increase of a mass by ≥50% in ≤6 months. The two other definitions of threshold growth used in the prior versions (a new observation ≥10 mm in ≤24 months and size increase of a mass by ≥100% in >6 months) are now considered as subthreshold growth, an AF that favors malignancy in general, but not HCC in particular. The change to threshold growth criteria downgrades a subset of observations that would have been categorized as LR-5 in older versions to LR-4 in v2018 (Fig. 4). However, this affects <1% of all LR-3 and LR-4 and only 2% of LR-5 observations.[9]

As an added bonus, the earlier changes allowed for removal of -g and -us designations previously used to subcategorize LR-5 observations, further simplifying LI-RADS.

CONCLUSION

Practice guidelines, as LI-RADS, are continuously evolving to standardize patient care based on the latest findings in evidence-based medicine. The recent updates to LI-RADS v2018 allowed for LI-RADS to be integrated into AASLD clinical practice guidance, making the first and crucial step toward system unification. Further updates based on evolving evidence will be needed to fully align the needs of radiologists, clinicians, and surgeons.

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